DEWEY

Methods of Feeding For Beef Production

Agriculture
B. S.
1904

A COMPARISON OF METHODS OF FEEDING FOR BEEF PRODUCTION.

BY

James Ansel Dewey, M. S., 1898

Thesis for the degree of
Bachelor of Science in Agriculture

in the

College of Agriculture
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1968

UNIVERSITY OF ILLINOIS

May 20 1904

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

James Ansel Dewey.

ENTITLED A Comparison of Methods of Feeding in Beef Production

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science

Herbert W. Mumford

HEAD OF DEPARTMENT OF Animal Husbandry

Object of the Experiment.

The object of this experiment was to determine the efficiency of the self-feeder* for beef production.

Plan of the Experiment.

Twenty steers after they were on full feed, were divided into two lots of ten each, the two lots being made as uniform in age, weight, condition, quality and thrift as possible. The one lot, designated throughout this experiment as Lot I. was fed by hand in open bunks, great care being taken that conditions of feeding from day to day were uniform and consistent with the best possible practice. All grain given each day was weighed and the weight recorded.

The other lot of ten steers was turned into a field in which a self-feeder was situated containing a known weight of the same concentrate as given Lot I. This lot is known throughout the experiment as Lot II.

The experiment was divided into periods of fourteen days and at the close of each period, the weight of the feed remaining in the feeder was determined and the weight of the cattle taken. Thus the gain for each lot and the grain consumed by each was determined for each period of fourteen days, from which data the economy of gains for each lot was obtained.

*The essential feature of a self-feeder consists of a bin so connected with a feed trough, or troughs, that when the bin contains feed there will always be a supply of the feed in the troughs. For description of the one used in this experiment see "concluding matter" near the close of this paper.

History and Description of Cattle.

The steers used in this experiment were purchased at the International Livestock Exposition in Chicago, December 1902, where they were the first prize car load of two-year old Short Horn feeding cattle. They then averaged 907 pounds in weight. During the late winter and early spring, they were divided and fed in an experiment to test the value of a paved feeding lot over one not paved. The ration consisted of broken ear corn and clover hay. After this experiment they were turned on pasture, the grain ration being reduced.

For some time previous to and including June 24, 1903 they received but 3.5 pounds of broken corn per steer per day . They refused to take the hard ear corn to any extent, while on grass. A ration of corn and cob meal was gradually substituted for the broken ear corn after June 24 and after this change, there was no trouble in increasing the ration. Thus on July 12 they ate greedily 200 pounds of the meal: on July 22, 300 pounds and on August 1, 400 pounds.

The cattle were divided into lots for this experiment on August 15, 1903. They were at that time a remarkably uniform lot of cattle. They were all high grade Short Horns, evidently very similarly bred, all having been raised by the Standard Cattle Company of Ames, Nebraska. In conformation and quality they presented an exceedingly small range of variation, very closely approaching the ideal beef type of their breed. In condition they were very uniform all being in good flesh as shown by the thick, even covering on the ribs, and in some cases, by a fullness of

History and Description of Cattle.

The steers used in this experiment were purchased at the Live-
periced Livestock Exposition in Chicago, December 1906, where
they were the first prize car lots of two-year old Short Horn
feeding cattle. They averaged1027 pounds in weight. During
the late winter and early spring,they were divided and fed in an
experiment to test the value of a ground feeding lot over one not
paved. The ration consisted of broken ear corn and clover hay.
After this experiment they were turned on pasture, the grain ra-
tion being reduced.

For some time previous to and including June 4th, 1908 they
received per head 7.5 pounds of broken corn per day . They
refused to take the ears ear corn to any extent, while on grass.
A ration of corn and cob meal was gradually substituted for the
broken ear corn after June 24 and after this change, there was
no trouble in increasing the ration. They on July 19 they
received 300 pounds of the meal: on July 29, 300 pounds
Record I, 400 pounds.

The cattle were weighed into lots for this experiment
August 17, 1908. They were at that time a reasonably uniform
lot cattle. They were all Short Horn grade Short Horns, evidently
principally bred, all having been raised by the Sylvester Davis
Company of Iowa, Nebraska. In conformation and quality they
showed an exceedingly small range of variation, very closely re-
presenting the ideal beef type of Short Bred. In handling they
were very quiet as can be seen from the fact that they were
easily controlled on the ride, and in open drive, by a children

the cod and an indication of fullness at the flank. In color they were mainly red. None had horns, having been dehorned at an early age.

Because of the uniformity in the cattle, the division resulted in two lots of steers well suited for a comparative test. The lot presenting the least variation in weight and in quality was put on the self-feeder (Lot II.). In Lot I. was the best steer and also the poorest one of the twenty. It aggregated 490 pounds heavier than Lot II.

Pasture, Shelter and Water-supply.

Each lot of cattle had the run of about 20 acres of pasture that furnishd an abundance of fresh clover and timothy grass. A forty acre field was divided and the self-feeder was placed in the most secluded half. Off one end of the pasture occupied by Lot I., a narrow lane was taken, which reduced its size about one half acre. This lot was also next to a pasture containing several cows which proved to be a disturbing factor for several days at the beginning of the experiment. The pasture occupied by Lot II. was a trifle lower and so perhaps produced somewhat better grass; yet both pastures gave more feed than was required by the stock. For the last ten days of the experiment, snow somewhat covered the pastures when clover hay was given to supplement the roughage.

No shelter was provided for either lot.

Water was supplied from a driven well. Each lot was supplied with a tank of ten to twelve barrel capacity. These were frequently cleaned.

the end and an indication of fullness at the base. In color
they were mainly red. Some had horns, evidently been removed at
an early age.

Because of the uniformity in the cattle, the statistics resulting
in two lots of steers will suffice for a comparative test. The lot
possessing the largest variation in weight was in reality one put
on the self-feeder (Lot II.). In Lot I. was the last steer and
also the poorest one of the bunch. It measured 400 pounds
heavier than Lot II.

Pasture, Shelter, Water-supply.

Each lot of cattle had the run of about 80 acres of pasture
land furnished an abundance of fresh clover and timothy grass.
Corn cribs were placed at the end of the pasture according to
the most accepted plan. Off one end of the pasture according to
Lot I., a narrow lane was taken, which reduced its size about one
half acre. This lot was also next to a pasture containing several
trees which proved to be a distinct factor for several days in
the beginning of the experiment. The pasture occupied by Lot II.
was a fertile level and no barriers produced possible [illegible]
but both pastured were more than was required in the [illegible]
for the lots for days at the experiment, some additional shelter
[illegible] was given: only was given to supplement the
[illegible].

No shelter was provided for either lot.

Water was supplied from a drilled well. Each lot was supplied
with a tank at rear to insure correct quantity. Those were [illegible]
[illegible]

Each lot was given all the salt the cattle wished, it being placed in boxes to which the cattle had access at all times.

Method of Feeding.

Corn and cob meal was used exclusively as the concentrate except during the last three weeks when O.P. linseed meal paa size was added to the corn and cob meal in the proportion of one pound of the oil meal to ten pounds of corn and cob meal. The grinding of the ear corn was done at a cost of ten cents per hundred weight, and in general the meal was finely ground. Never more than two tons of the meal was on hand at one time and as it was stored in sacks no trouble was occasioned by heating and souring. The sacks contained slightly varying proportions of corn to cob due to the separation of the lighter cob from the heavier corn, as the meal fell from the spout at the mill.

The self-feeder required but little attention after filling. When it was nearly empty and during damp weather the meal would not always run down into the bunks at all places, but a sharp blow on the outer wall would generally start it. During several rain storms accompanied with wind, water collected in the bunks and moistened the meal at the outlets, so that it had to be removed from before the openings. It was left in the bunks however, and was eaten without waste. Fifteen pounds of grain, removed October 9 was a little sour and so was discarded. This was the total of loss from this cause. The cattle wasted but very little from the bunks while eating: Some loss of feed from the self-feeder was occasioned by sparrows that helped themselves from the troughs.

Lot I was fed but once a day - at five o'clock in the afternoon. It was the endeavor to give them as much of the meal as would be entirely consumed within a reasonable time. In general it took the steers a little less than an hour to clean up the bunks at each feeding. The quantity of grain required for a feed remained very constant throughout the entire feeding period, it being twenty pounds per steer per day.

No account was made of hogs following as the cattle were fed on grass and because the feed was ground.

It should be observed that the conditions prevailing at the beginning of the experiment were such as to give the cattle fed at the self-feeder an exceedingly favorable opportunity for economical beef production by such a method of feeding. The cattle were accustomed to liberal grain feeding, were well aged and were well started, or in other words, well "warmed up". They were brought up to a full feed with care, some six weeks being taken in the process. Under such conditions, at least according to common belief, the self-feeder was given a most favorable opportunity to make a good showing for this system of feeding. It will also be noted that when conditions during the experiment could not be maintained exactly equal for the two lots, the trifling advantage was given to the self-feeder cattle. Thus in the matter of pasture, the self-fed cattle had a trifle the best and largest field. It was more secluded and there was no other cattle except Lot I near it. The gain was more uniformly made: the cattle themselves, though not so heavy were more uniform in character. These variation in conditions are of small practical importance

yet because of some popular prejudice against the self-feeder, it was our endeavor to be clearly fair to this method of feeding.

Table I. The weight of each lot at the close of each period of fourteen days: the total gains and the daily gains per steer for each lot from the beginning of the experiment to the end of each period of fourteen days.

	Weight of cattle at the close of each period of fourteen days.		Total gain from the beginning of the experiment to the end of each period of fourteen days.		The daily gain per steer since the beginning of the exp. to the end of each period of 14 days.	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
August 15	13260	12770				
August 15 to August 29	13705	13160	445	390	3.178	2.786
August 29 to September 12	14040	13585	780	815	2.7857	2.9107
September 12 to September 26	14340	13900	1080	1130	2.5714	2.6905
September 26 to October 10	14560	14170	1300	1400	2.3214	2.5000
October 10 to October 24	15050	14540	1790	1770	2.5571	2.5285
October 24 to November 7	15190	14800	1930	2030	2.2976	2.4167
November 7 to November 21	15540	15280	2280	2510	2.326	2.561

The total gains, given in table I, for each lot for the whole feeding period of 98 days amounts to 2280 pounds for Lot I and 2510 pounds for Lot II. This is228 pounds per steer in Lot I during the 98 days, an average gain of 2.326 per steer per day. For Lot II the average gain per steer for the 98 days is 251 pounds or 2.561 pounds per steer per day. It is seen that more rapid gains were secured by the use of the self-feeder. The total gain of the self fed cattle exceeds that of the hand fed by 230 pounds, equivalent to 10.09% of the hand fed steers' total gain. The daily gain per steer in Lot II is .235 pounds above that of Lot I.

Table. Weight of cattle, total gain, and average daily gain for each period of fourteen days.

	Weight of cattle at the close of each period.		Total gain in each period of fourteen days.		Gain per day per steer in each period of fourteen days.	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
August 15	13260	12770				
August 15 to August 29	13705	13160	445	390	3.178	2.786
August 29 to September 12	14040	13585	335	425	2.393	3.135
September 12 to September 26	14340	13900	300	315	2.143	2.250
September 26 to October 10	14560	14170	220	270	1.571	1.928
October 10 to October 24	15050	14540	490	370	3.500	2.643
October 24 to November 7	15190	14800	140	260	1.000	1.857
November 7 to November 21	15540	15280	350	480	2.500	3.428

Table II gives us the gains of each lot during each period of fourteen days. The average gain of Lot I during a period of fourteen days is 325.7 pounds and for Lot II is 358.5 pounds. A glance at the table shows that the gains of Lot I present the greatest variation in extremes from its average. In fact during the fifth period Lot I made the largest gain recorded by either lot during the whole experiment, viz., 3.5 pound per steer per day, while during thesixth, or following period it made the least gain recorded during the entire experiment, i.e., one pound per steer per day. An average of the total gains of these two consecutive periods is 315 pounds, and amount very near to the total average gain per period for Lot I. Such variations, though common in experiments in feeding, have not yet been satisfactorily explained.

The points to especially observe in Table II are: (1) That gains are much more uniform from period to period for the self-fed cattle than for the hand fed. Thus the average daily gain per steer differs but .867 pounds from the greatest extreme for Lot II while the average daily gain per steer differed 1.326 pounds from its greatest extreme. (2) Although the first four periods show a gradual decrease in quantity of gain (especially noticeable in Lot I) yet the gains in the final periods do not continue to show this decrease. In fact Lot II made its largest gain for any one period during the last feeding period. In Lot I the gain for the last period is some 25 pounds above the average.

Curve I, Chart I gives a graphic representation of these points. The broken lines representing the gains for Lot II is much more even throughout its course than is the solid line which

Table II gives us the gains of each lot during each period of fourteen days. The average gain of Lot I during a period of fourteen days is 327.7 pounds and for Lot II is 300.[illegible] pounds. A glance at the table shows that the gains of Lot I present the greatest variation in extremes from its average. In fact with the fifth period Lot I made the largest gain recorded by either lot during the whole experiment, viz., [illegible] pounds per steer per day, while during the sixth, or following, period it made the least gain recorded during the entire experiment, i.e., one pound per steer per day. An average of the total gains of these two consecutive periods is [illegible] pounds, and comes very near to the total average gain per period for Lot I. Such variations, though common in experiments in feeding, have not yet been satisfactorily explained.

The points to especially observe in Table II are: (1) That gains are much more uniform from period to period for the silage cattle than for the hand fed. Thus the average daily gain per steer differs but [illegible] pounds from the greatest extreme for Lot II while the average daily gain per steer differs [illegible] pounds from its greatest extreme. (2) Although the first three periods show a general increase in quantity of gain (especially noticeable in Lot I) yet the gains in the final periods do not continue to show this increase. In fact Lot II made its largest gain for any one period during the last (seventh) period. In Lot I the gain for the last period is about [illegible] pounds above its average.

Curve I, Chart I gives a graphic representation of these points. The broken lines representing the gains for Lot II is much more even throughout its course than is the solid line [illegible]

represents the gains for Lot I. And though for the first four periods both lines ascend, indicating decreasing gains yet during the fifth and seventh periodsvery heavy gains are indicated.

During the sixth period in which the small gain was secured, an effort was made to increase the ration for the hand fed steers. They had been getting up to this time between nineteen and twenty pounds per steer per day while Lot II was taking twenty one to twenty two pounds per steer per day. A gradual increase was made in the ration of Lot I till twenty one pounds per steer per day was reached when a small portion of feed was left in the bunk not eaten. The allowance was dropped to seventeen and one half pounds the next day, then brought back to twenty pounds and held there. Though this slight irregularity did no apparent damage yet when the scales indicated an unprofitable gain for the whole period of two weeks, the question naturally arose as to whether the interruption in regularity was the cause of this unprofitable gain. The evidence would be stronger of the change in ration being the cause of the small gain had not Lot II made its maximum gain in the period immediately preceding. As previously stated, the average gain of these two periods was normal.

However, it was noticed that the hand fed cattle, when on full feed were exceedingly sensitive to any change in condition and the above incident is an indication that very small changes in this method of feeding may lead to rather large reduction in gains*.

*It is possible that the sudden introduction of the oil meal into the ration of both lots during the sixth period was a factor in producing small gains. The oil meal had a laxative effect, yet at no time did theloosening of the bowels become sufficient to cause a suspicion of its retarding the gains.

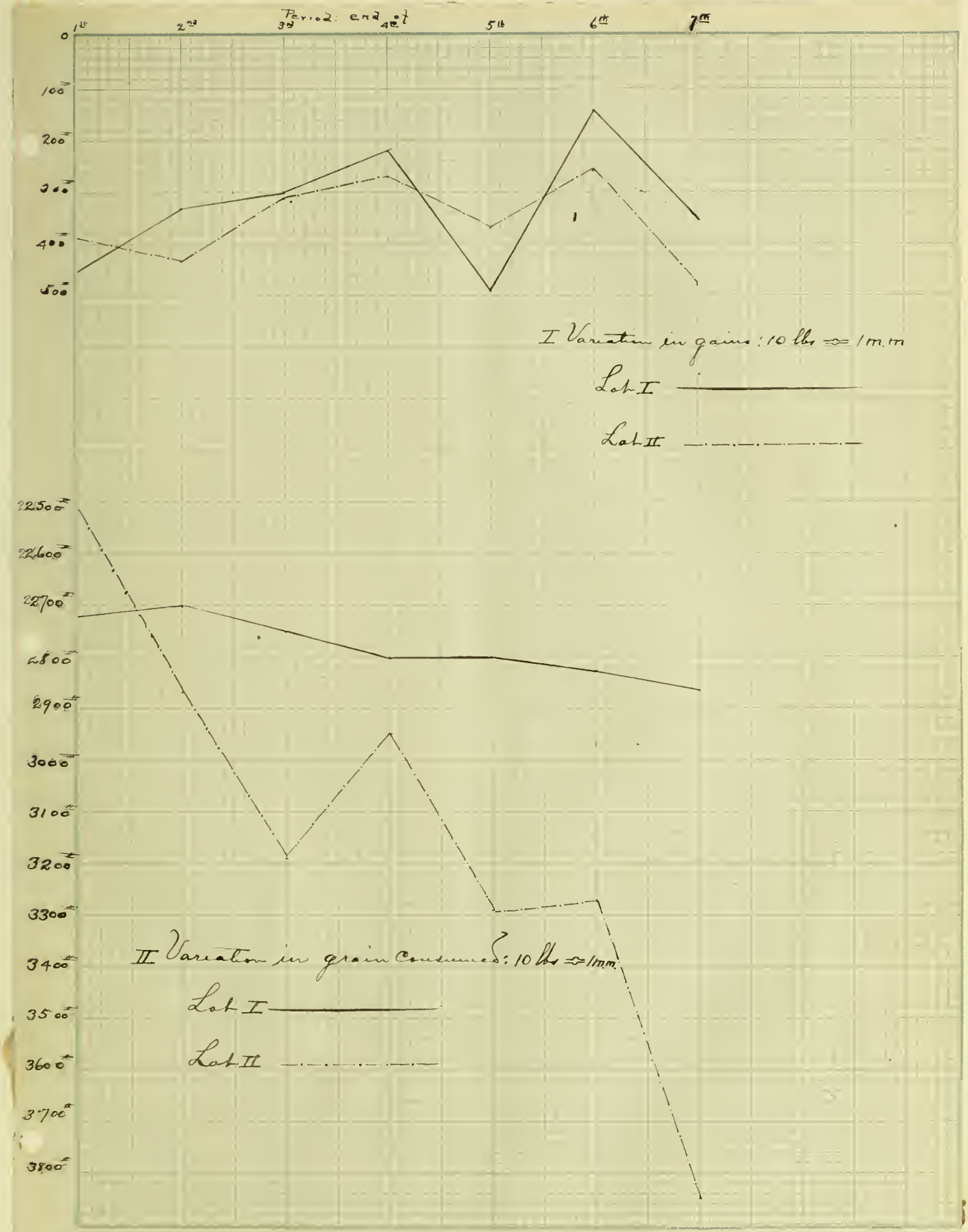
Period: end 4th
1st
2nd
3rd
5th
6th
7th
0
100
200
300
400
500
I Variation in gains: 10 lbs = 1 m.m
Lot I
Lot II
2250
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
II Variation in grain Consumed: 10 lbs = 1 mm
Lot I
Lot II

Chart I

The similarity in the fluctuations in gains for Lots I and II is quite striking. As no such corresponding variation occurred in the quantity of feed consumed, other factors must have occasioned it. In order to see if variations in weather condition corresponded with variations in gains Chart II has been prepared.

Curve I of this Chart is the same as Curve I of Chart I. Curve II of Chart II is made by platting the average temperature of each period, obtained by averaging the mean daily temperatures of the days of each period. In general, as the season advances the average temperature becomes lower with slight fluctuations. The variations would indicate that the light gains were made during seasons warmer than the general direction of the curve would indicate as normal for that season. Thus the gains during the fourth and sixth periods were markedly lower than the average, and the average temperature for these periods is considerably higher than the general direction of the line would indicate as normal. Though the evidence is insufficient for any definite statement yet it is quite suggestive that there may be a connection between extent of gains and temperature.

Curve III of Chart II, representing the variations in the average mean daily humidity is extremely irregular and no definite relation exists between this and tne gain curve. The lightest gains were made during the period with the least average relative humidity while large gains were recorded during the last period, when the average relative humidity was the highest. This seems contradictory to the ordinary opinion among practical feeders. Of course, the average mean daily humidity corresponds

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Curve III of Chart II, representing the variations in the average mean daily humidity is extremely irregular and no definite relation exists between this and the gain curves. The greatest gains were made during the period with the least average relative humidity while large gains were recorded during the last period, when the average relative humidity was the greatest. This seems contradictory to the ordinary opinion among practical feeders. Of course, the average mean daily humidity expressions

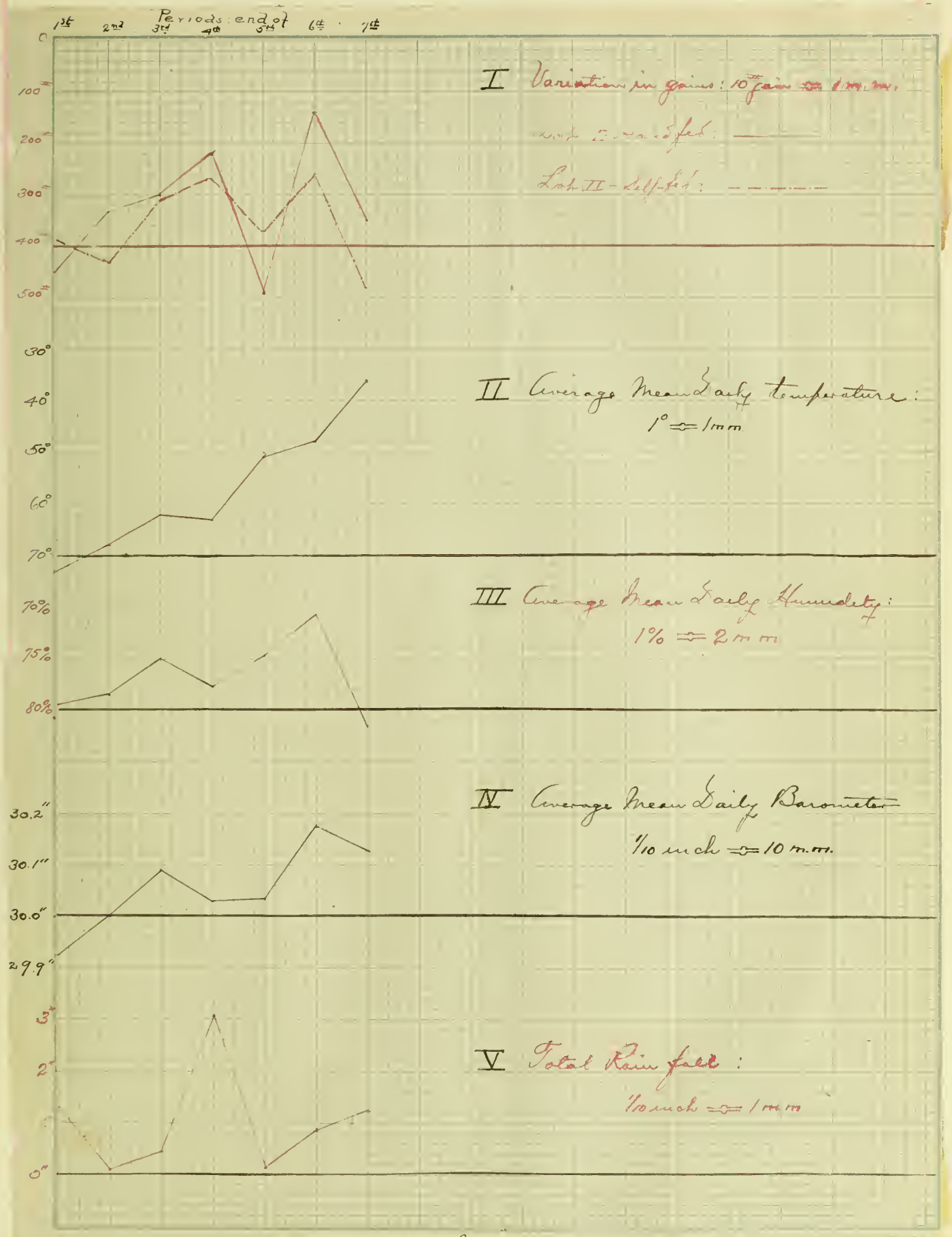

Periods: end of 1st 2nd 3rd 4th 5th 6th 7th
0
100
200
300
400
500
I Variation in gains: 10 gain = 1 m.m.
Lock I - self-fed:
Lock II - self-fed:
30°
40°
50°
60°
70°
II Average Mean Daily temperature:
1° = 1 m.m.
70%
75%
80%
III Average Mean Daily Humidity:
1% = 2 m.m.
30.2"
30.1"
30.0"
29.9"
IV Average Mean Daily Barometer
1/10 inch = 10 m.m.
3"
2"
1"
0"
V Total Rain fall:
1/10 inch = 1 m.m.

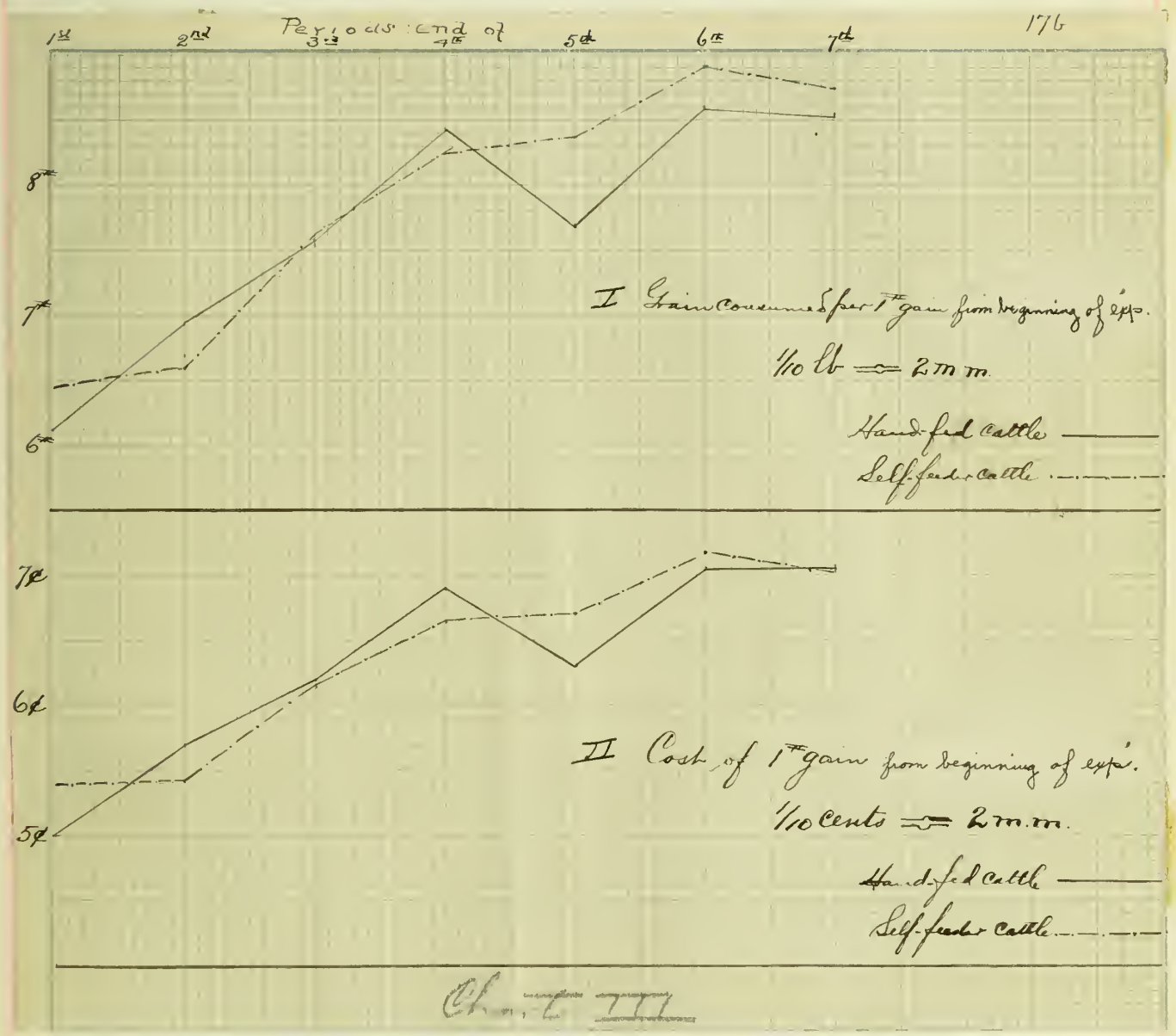
Chart II

more or less closely with the average mean daily barometer (Curve IV), each being the result of passing high and low areas of atmospheric pressure. One would expect that variations in rainfall would correspond more or less closely with variation in barometer. Curve V does not bring this out clearly. The slight evidence from Curve V is that large rainfall and light gains go together.

The entire study would lead one to suspect that variations in temperature exerted some influence upon gains but that barometric changes with the accompanying phenomena of variations in rainfall and relative humidity do not affect gains. Positive general statements should not be made from this data.

A Study of Weight of Grain Consumed.

The weight of grain fed Lot I was held quite constant at about twenty pounds per steer per day, and this amount seemed to nearly meet their capacity at all times unless it was for the very last few days of the feeding when the weather was cold and clear. The feature that is most striking in Table III is the small weight of grain consumed by each lot. Though the cattle were large and well aged yet but little over a peck was taken by each steer when he was eating all he would. The selffeeder cattle increased toward the close of the experiment till during the last period they consumed a little over one third of a bushel, yet at no time did either lot consume the half bushel so commonly assumed to be the full feed of so large steers. Computing from the data given in Table III it is found that Lot I consumed on an average, .27 bushels per day per steer and that Lot II required .31 bushels


1st
2nd
Periods: end of
3rd
4th
5th
6th
7th
8th
7th
6th
I Grain Consumed per 1th gain from beginning of exp.
1/10 lb = 2 m.m.
Hand-fed cattle
Self-feder cattle
7th
6th
5th
II Cost of 1th gain from beginning of exp.
1/10 cents = 2 m.m.
Hand-fed cattle
Self-feder cattle

Ch. I III

per day per steer.

An interesting point b ought out in Table IV is, that, while the grain for Lot I remained quite constant, that for Lot II was irregular from period to period increasing rapidly as the feeding continued.

In connection with the study of grains, it would seem that with the hand fed cattle the grain consumed being the constant, the gains were the variable quantities, while with the self-fed cattle the grain consumed was the variable and the gains the more nearly constant.

In Chart I we have these facts presented in a graphic form. While the broken line in Curve I, representing the gains for Lot II, is comparatively even, in Curve II where it represents the grain consumed by Lot II it is exceedingly variable. It is also seen that while there is almost constant increase in the weight of grain consumed by Lot II there is no such increase in gains. However, with Lot II, there is a slight correspondence in variations in the lines representing gains and grain consumed, while with Lot I there is no such similarity. The possibility suggests itself from the study of so varying the grain ration in a method of hand feeding that the gains shall be held uniform. The question naturally arises whether any method could be adopted that would make this adjustment better than that of some method of selffeeding.

A possible explanation of this small average daily consumption, is the fact that these steers, beside being high grades of one of the beef breeds, had never been fed on a bulky ration of low nutritive value, those compelling them to consume large quantities offered to satisfy their hunger. And so their digestive apparatus had acquired the ability of utilizing a large percentage of the digestible content of the food. It is seen that the economy of gain expressed in grain consumed is above that usually obtained in cattle feeding.

Table III. Weight of grain consumed; grain consumed for one pound gain, cost of each pound gain, for each lot, from the beginning of the experiment to the end of each period of fourteen days.

	Corn + cob meal consumed from the beginning of the experiment to the end of each period of fourteen days.		Linseed meal consumed by each lot from the beginning of the experiment to the close of each period of fourteen days.		Corn + cob meal consumed per one pound of gain in beef from the beginning of the experiment to the end of each period of fourteen days.		Linseed meal consumed per one pound of gain in beef from the beginning of the experiment to the end of each period of fourteen days.		Cost of one pound of gain since beginning of experiment. Up to close of each period of 14 days with corn + cob meal at $12 ton, oil meal $48 ton, pasture at 30¢ per steer per week,	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
August 15 to August 29	2.120	2518			6.112	6.456			.05016	.05412
August 29 to September 12	5420	5385			6.9487	6.6073			.05708	.05437
September 12 to September 26	8170	8576			7.5648	7.5894			.06206	.06147
September 26 to October 10	10970	11532			8.4385	8.2371			.06909	.06657
October 10 to October 24	13770	14821			7.6927	8.3734			.06292	.06719
October 24 to November 7	16467.2	17934.6	1278	1564	8.532	8.834	.066	.077	.07068	.07171
November 7 to November 21	19071.8	21436.4	3882	5066	8.365	8.540	.170	.202	.07074	.070498

Table IV. Weight of grain consumed by each lot for each period of fourteen days, the grain consumed for one pound gain by each lot for each period of fourteen days, and the price of each pound gain by each lot for each period of fourteen days at specified value for feed-stuffs.

	Corn + cob meal consumed in each period of fourteen days.		Linseed meal consumed in each period of fourteen days.		Corn + cob meal consumed for one pound of beef secured in each period of fourteen days.		Linseed meal consumed per one pound gain in beef in each period of fourteen days.		Cost of one pound of gain with corn + cob meal at $12 per ton; oil meal at $25 per ton; pasture at 30¢ per steer per week.	
	Lot I	Lot III	Lot I	Lot III	Lot I	Lot II	Lot I	Lot III	Lot I	Lot III
									#	#
August 15 to August 29	2720	2518			6.112	6.456			.05015	.05413
August 29 to September 12	2700	2867			8.060	6.746			.06627	.05459
September 12 to September 26	2750	3191			9.166	10.130			.07500	.07983
September 26 to October 10	2800	2956			12.727	10.948			.10364	.08791
October 10 to October 24	2800	3289			5.714	8.889			.04653	.06955
October 24 to November 7	2697.2	3113.6	127.8	156.4	19.266	11975	.913	.6015	.16986	.10245
November 7 to November 21	2604.6	3501.8	260.4	350.2	7.441	7.295	.744	.730	.07109	.06539

From a study of the data in Table III giving the weight of feed required for one pound gain it is seen that the total variation of grain consumed to gain secured, was greater with Lot I when the feed given was held constant than with Lot II when gains were more nearly constant and the weight of grain more variable. Thus the fluctuations with the hand fed cattle are between 20.179 pounds grain per one pound gain as a maximum and 5.714 pounds per one pound gain as a minimum, while with Lot II the extremes are 12.577 pounds as a maximum and 6.456 as a minimum.

In determining the cost of a pound of gain the following prices were set on the various feeds entering into the ration:

Corn and cob meal	$12 per ton
O.P. Linseed meal	25 per ton
Pasture	30 cents per steer. per week.

Of course the expense for one pound gain is nearly proportional to the grain consumed for one pound gain, yet not quite so because of the fact that the gains for each lot being different, the pasture bill which is a constant stands for a varying proportion of the expense.

Although the gain of the self-fed cattle exceed that of the hand fed by 10.09%, yet Lot II ate 2483 pounds more grain than did Lot I, which is equivalent to 12.75 per cent of the hand fed steers total amount eaten. Thus in economy of gain expressed in weight of grain per one pound of gain Lot I is superior, there being a saving of .207 pounds of grain on every 8.535 pounds consumed, equivalent to 2.42 per cent.

When we look at the expense of gains expressed in cents per one pound gain, we find the reverse true : i.e. the self fed cattle are superior to the hand fed by .0243 cents per one pound gain. This apparent contradictory state of affairs is explained as follows. The cost expressed in cents per one pound gain includes a pasture bill of $42 for each lot. The hand fed cattle made, then, 2280 pounds gain on $119.29 worth of grain and $42 of pasture, i.e. it took 5.232 cents of grain ($119.29 ÷ 2280) and 1.8421 cents of pasture ($42 ÷ 2280) to make one pound of gain. With Lot II, the gain of 2510 pounds was made on $134.95 worth of grain and $42 of pasture: i.e., it took 5.3765 cents of grain ($134.95 ÷ 2510) and 1.6733 cents of pasture ($42 ÷ 2510) to make one pound of gain. It is seen that Lot I produced one pound of gain .1445 cents more cheaply than Lot II in its grain bill (5.3765- 5.2320) but in its pasture bill .1688 cents less cheaply (1.8421- 1.6733), this latter sum being .0243 cents the larger (.1688 - .1445). Thus Lot I makes a pound gain .0243 cents less economically than does Lot II.

Chart III gives us in a graphic form the economy of gains expressed both in grain (Curve I) and in cents (Curve II) for one pound gain. The insertion of the pasture bill in Curve II changes the relative position of the curves at the end of the second and seventh periods. In general the curves where total cost is platted are nearer together than when grain costs alone are platted. It will be seen that had the experiment been terminated at the end of other periods, different results would have been secured.

It is customary in reporting the grain consumed per one pound gain to reduce the grain weight to a dry basis. Table V gives us in the first two columns the grossweight of grain per one pound gain during each feeding period for each lot. From these weights the weight of"dry matter", of total digestible matter, of protein, of carbohydrate, and of ether extract for one pound gain is calculated. In our calculations the following per cents were used:

	Dry Weight % of gross weight	Digestible Weight % of dry matter	Protein % of gross weight	Carbo hydrate % of gross weight	Ether Extract % of gross weight
Corn & cob meal	84.9	79	4.4	60	2.9
O.P.linseed meal	90.8	79	29.3	32.7	7

Table VI gives us the same information in the same order except that the weights are calculated from the weight of grain per one pound gain from the beginning of the experiment to the close of each period.

Without a definite knowledge of the amount of roughage and the character of the gain we are handicapped in the study of this data. Doubtless, the gain in weight was due almost entirely to the laying on of fat, which fat must in quite large part have come from the carbohydrate of the ration as the ether extract and proteids were not sufficient to produce any considerable part of the gain. The nutritive ratio of the average grain ration is 1:155 for Lot I and 1:152 for Lot II, the difference resulting from the large weight of grain eaten by Lot II during the last period when oil meal formed one tenth the grain ration. It is to be presumed that the mixed pasture grass narrowed the ratio materially, yet without knowing the proportion of the pasture to the grain in the ration, the exact nutritive ratio of the entire ration can not be determined.

Table V. Gross weight, weight of dry matter, weight of total digestible matter, of proteid, of carbohydrate and of ether extract, in the grain consumed for one pound gain in beef for each lot, in each period of fourteen days.

	Weight of grain, of dry matter in grain and of digestible nutrients in grain consumed for one pound gain in each period of fourteen days.											
	Gross weight of grain consumed for one lb. of gain in beef for each lot in each period of 14 days.		Dry matter in grain consumed for one lb gain in beef for each lot in each period of 14 days.		Digestible nutrients consumed for one pound gain in each period of fourteen days.							
					Total digestible, weight.		Protein		Carbohydrate		Ether Extracts	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
August 15 to August 29	6.112	6.456	5.189	5.481	4.113	4.345	.269	.284	3.667	3.874	.177	.187
August 29 to September 12	8.060	6.746	6.843	5.727	5.424	4.540	.355	.297	4.836	4.048	.234	.196
September 12 to September 26	9.166	10.130	7.782	8.600	6.169	6.817	.403	.446	5.499	6.078	.266	.294
September 26 to October 10	12.727	10.948	10.805	1.295	8.565	7.368	.560	.482	7.636	6.569	.369	.317
October 10 to October 24	5.714	8.859	4.851	7.547	3.876	5.952	.251	.391	3.429	5.333	.166	.257
October 24 to November 7	20.179	12.577	17.186	10.703	13.577	8.455	1.115	.703	11.858	7.382	.623	.389
November 7 to November 21	8.185	8.025	6.993	6.856	5.524	5.416	.545	.535	4.708	4.615	.268	.263

Table VI. Gross weight, weights of dry matter, weights of total digestible matter, of proteid, of carbohydrate, and of the extract, in the grain consumed for one pound of gain in beef for each lot, from the beginning of the experiment to the close of each period of fourteen days.

	Weight of grain of each period for 100 lbs. gain		Dry matter in grain consumed for one lb. gain from beginning of the exp. to the close of each period of fourteen days.		Digestible nutrients consumed for one lb. gain from beginning of exp. to close of each period of 14 days							
	Gross weight of grain consumed for one lb. gain from the beginning of the experiment to the close of each period of 14 days				Total Digestible Weight		Protein		Carbohydrate		Ether Extract	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
August 15 to August 29	6.112	6.456	5.189	5.481	4.113	4.345	.269	.284	3.667	3.874	.177	.187
August 29 to September 12	6.949	6.607	5.899	5.509	4660	4.353	.306	.291	4.169	3.964	.202	.192
September 12 to September 26	7.565	7.589	6.432	6.444	5.074	5.090	.333	334	4.539	4.554	.219	.220
September 26 to October 10	8.438	8.237	7.164	6.993	5.660	5.525	.371	362.	5.063	4.942	.245	.239
October 10 to October 24	7.693	8.373	6.531	7.109	5.160	5.616.	.338	.3684	4.616	5.024	.223	.242
October 24 to November 7	8.598	8.912	7.304	7.571	5770	5.981	.345	411	5.141	5.326	.252.	.262
November 7 to November 21	8.535	8.742	7.254	7.434	5.732	5.873	418	435	5.075	5.190	254	.262

In all of our calculations to this point we have assumed the constant or unit to be one pound of gain, the comparison being between the amounts of gain necessary to produce this unit gain. Should we make a bushel of corn or a thousand pounds of grain the unit, comparing the gains made from it we would have the following table:

	Lot I	Lot II
Pounds of beef produced per 1000 pounds of dry matter in grain consumed	137.8	134.5
Pounds of beef produced per one bushel (70#) grain consumed.	8.273	8.007
Percent of dry matter in grain converted into beef	13.78	13.45

The hand fed cattle show a slight superiority over the self fed cattle.

The Financial Statement.

The cost of feed for the cattle since their purchase in December, 1902 to August 15, 1903 amounted to $669.18. Their initial cost was $902.75, making a total cash expenditure to August 15, 1903 of $1571.93. As they weighed 26030 pounds on August 15 they then would have had to sell for $6.04 per hundred pounds to have cleared the expense. When the cattle were divided on August 15 the total expense to that date was divided between the two lots in direct proportion to their weights, the hand fed steers being accredited $800.76 for their share and Lot II $771.17 for theirs. Table VII gives the data since August 15, 1903.

The price necessary to cover expenses for Lot I continually in-

Table III. Financial statement giving weight & value of feed consumed for each period of 14 days; total expense of cattle at close of each period of 14 days (including initial cost of cattle & cost of grain & pasture since the purchase), weight of cattle at close of each period of 14 days, & price cattle must bring per cwt. to clear total expense of initial cost and of feed consumed

	Weight of grain consumed in each period of fourteen days for each lot.		Value of grain consumed in each period of fourteen days for each lot.		Value of pasture occupied by each lot; each steer charged 30¢ per week.		Total expense incurred by each lot up to beginning of each period of 14 days.		Total expense in cattle in each lot at close of each period of fourteen days.		Weight of each lot at close of each period of fourteen days.		Price per cwt. the cattle of each lot must bring to clear expenses.	
	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II	Lot I	Lot II
	#	#	#	#	#	#	#	#	#	#	#	#	#	#
August 15 to August 29	2720	2518	16.32	15.11	6.00	6.00	800.76	771.17	823.08	792.28	13705	13160	6.00	6.02
August 29 to September 12	2700	2867	16.20	17.20	6.00	6.00	823.08	792.28	845.28	815.48	14040	13585	6.02	6.00
September 12 to September 26	2750	3191	16.50	19.14	6.00	6.00	845.28	815.48	867.78	840.62	14340	13900	6.05	6.05
September 26 to October 10	2800	2956	16.80	17.74	6.00	6.00	867.78	840.62	889.58	86436	14560	14170	6.11	6.10
October 10 to October 24	2800	3289	16.80	1973	6.00	6.00	889.58	86436	912.38	890.09	15050	14540	6.06	6.12
October 24 to November 7	2825	3270	17.78	20.63	6.00	6.00	912.38	890.09	936.16	916.72	15190	14800	6.16	6.19
November 7 to November 21	2865	3852	18.88	25.39	6.00	6.00	936.16	916.72	961.04	948.11	15540	15280	6.18	6.20

increased except at the end of the fifth period when the gains had been sufficiently economical so that the $6.11 quotation of October 10 is reduced to $6.06. The following period more than off set this advantage. In Lot II, except for a decrease of two cents during the first period, there was an increase for each succeeding period. At the close of the test, Lot II has cost two cents more per hundred weight than had Lot I. As the cattle averaged 1541 pounds at the close of the experiment, their superiority amounts to 31 cents a head.

On November 21, eighteen head of the twenty were shipped to Chicago. The two left were about average in weight and quality. The eighteen head sold for $5.40 per hundred weight making a loss of $.78 per cwt. for Lot I and of $.80 per hundred weight for Lot II. Using our last weighing, this makes a loss of $121.21 on Lot I and of $122.24 on Lot II. Thus it will be seen that these amounts are practically equal, being but $1.03 to the advantage of Lot I.

Two factors work together to bring these results so nearly the same. (1) Lot II though they made a few pound of gain at about the same expense as did Lot I yet because they made more pounds gain incurred a greater loss, for, in both cases, a pound of gain sold for about 1.6 cents less than it cost. This disadvantage to the self-fed cattle was off-set by the second factor: namely, the loss per hundred weight was more serious to the lot that had the greater weight, i.e. the greatest number of hundred weight upon which to lose. As Lot I was heavier this factor increased the deficit incurred by their feeding.

We have not placed to the credit of Lot II the saving in labor that the self-feeder gives. It is difficult to determine what this advantage is. It would not be just to assume that the difference in time given to the lots in this experiment was the same as that in general practice, for here, no time was spared to make our results accurate. It is quite impossible to make a specific statement of this saving in actual practice for under some circumstances where a man is employed to do other work, it is possible that the morning and evening feeding does not increase the expense at all, as it may not interfere with his other work. On the other hand, the saving may be all important. It may require the employment of an extra hand and it is very difficult to obtain help that is able to feed by hand in a profitable manner. As skilled labor becomes higher and more difficult to obtain, the advantage that the self-feeder possesses as a time saver will increase in importance.

Conclusions.

This experiment indicates that

(1) More rapid gains can be secured by the use of the self-feeder than by feeding by hand in the ordinary way.

(2) The gain with the self-fed cattle is subject to less variation while the grain consumed is subject to considerable variation.

(3) While the gains are greater, the grain consumed by the self-fed cattle is also greater: so much so that in the experiment the gains for the self-fed cattle were made slightly less economically in gain than for the hand-fed cattle. The self-feeder

cattle made a total gain of 2510 pounds in the 98 days of feeding while the hand fed lot gained but 2280 pounds. The self-fed cattle consumed 21943 pounds of grain while the hand fed lot consumed but 19480 pounds. Thus in economy of gain, the self-fed lot made a pound of gain with 8. 742 pounds of grain while the hand-fed lot required but 8.535 pounds of grain for one pound of gain.

(4) The advantages in favor of the hand-fed cattle are so slight that the results can easily be accredited to differences in average beef-producing efficiency of the two lots and to small differences in surroundings beyond the control of the operators of the experiment. It should be recalled in this connection, however, that the cattle at the beginning of the experiment were in such condition as to respond most favorably to the self-feeder process.

(5) In final terms there is not sufficient evidence from this experiment to establish one method superior to the other in efficiency for beef production.

(6) There is no evidence from the experiment that variations in humidity and barometric pressure occasion the variation in gains. It is seen, however, that periods during which light gains were made, were the periods that had a higher average mean daily temperature than was normal for such periods for the season.

Construction of the Self-feeder.

The self-feeder is twelve feet long (inside measure) and eight feet wide in the region of the bunks, each bunk being two feet wide and the bottom of the bin four feet. The whole structure rests upon three pairs of 6" x 6" posts set one and one half feet out of the ground, each pair being six feet apart and the posts of a

pair four feet apart. Across the top of each row of posts is firmly spiked a 6" x 6" sill twelve feet long. Resting on the sillsare seven 2" x 6" joist eight feet long, upon which is nailed the floor of the bunks, consisting of five twelve foot lengths of 1" x 6" matched flooring for each bunk. The outer edges of the bunks are made of 2" x 12" plank twelve feet long, spiked to the ends of the joist and projecting six inches above the floor. The floor of the bin is raised along the center to a peak two feet above the level of the floor of the bunks, by seven pair of 2" x 4" rafters, cut two feet ten inches extreme length, and set on the joist. Each side of this raise is covered with seven twelve feet lengths of 1" x 6" matched flooring, making a continuous covering with the bunk floor. Resting upon the 6" x 6" sills, arise seven pair of studs to form the sides of the bin and to support the roof. These studs come through the floor so as to necessitate the fitting of the first board on the raise of the hopper bottom about them. They are two feet apart and are spiked to the joist next to which they stand. (The end pair are placed on top of the 2" x 6" end joist). To support the end of the floor board cut by the studding that is not supported by the joist, is a small 2" x 4" peice with lower end resting on the 6" x 6" sill and the upper end fitted next the floor. This piece is spiked to the adjacent stud. The studs are eight feet long and are set flaring outward, being four feet apart at the base and eight feet apart at the top. Each pair is tied together at the top, by an eight feet 2" x 4" joist. Across the top of each row of studs is a twelve feet 2" x 4" plot. To enclose the sides of the bin

pair four feet apart. Across the top of each row of posts is firmly spiked a 4" x 4" sill twelve feet long. Resting on the sills are seven 2" x 6" joist eight feet long, upon which is built the floor of the bunks, consisting of five twelve foot lengths of 1" x 6" matched flooring for each bunk. The outer edges of the bunks are made of 2" x 12" plank twelve feet long, spiked to the ends of the joist and projecting six inches above the floor. The floor of the bin is raised along the center to a peak two feet above the level of the floor of the bunks, by seven pair of 2" x 4" rafters, cut two feet ten inches rafters length, and set on the joist. Each side of this raise is covered with seven twelve feet lengths of 1" x 6" matched flooring, making a continuous covering with the bunk floor. Resting upon the 4" x 4" sills, are seven pair of studs to form the sides of the bin and to support the roof. These studs come through the floor so as to necessitate the slitting of the first board on the sides of the upper bottom about them. They are two feet apart and are spiked to the joist next to which they stand. (The end pair are placed on top of the 2" x 6" end joists). To support the end of the floor board out of the studding that is not supported by the joists, is a small 2" x 4" plate with lower end resting on the 4" x 4" sill and the upper end fitted under the floor. This piece is spiked to the adjacent stud. The studs are eight feet long and are set flaring outward, being four feet apart at the base and eight feet apart at the top. Each pair is tied together at the top, by an eight foot 2" x 4" joist. Across the top of each row of studs is a twelve foot 2" x 4" plate. To enclose the sides of the bin

thirteen peices of 1" x 6" matched flooring twelve feet long are nailed to outside of studs, a space of two inches being left at the bottom to permit the feeding out of the grain into the bunks from the hopper.

The roof is supported by a pair of 2" x 4" rafters cut seven and one half feet long. The ridge is four feet above the upper joist and the eaves are about two and one half feet deep, sufficient so that the drip of the roof falls outside the bunks. The rafters are matched to fit the plate. At one half the distance between plate and ridge a 2" x 4" piece is cut to fit in between the pairs of rafters to keep the roof from sagging. At the end of the rafters on each side a 1" x 6" board twelve and one half feet long is nailed, thus extending out three inches at each end. The roof consists of twelve and one half piece of 1" x 12" grooved roofing on each side, the covering extending out to the ends of the boards at the ends of the rafters, thus forming a three inch projection at the ends. On each crack a 1/2" x 3" batt is placed. At each end are two studs resting upon the end pair of floor rafters. They are two feet apart, one foot from the ridge in the floor, and are cut eight feet to extend to the end pair of roof rafters. They are notched to meet the end 2 " x 4" ties for the end pair of studs. The entire end from eave to eave down to the 6" x 6" sills is covered with 1" x 6" matched flooring, thus enclosing the ends of the bunks. Above the end ties [illegible] each end is swung a two feet by two feet door.

Following is a bill of lumber used in the construction as given above.

7	pieces	2" x 4"	cut	5 feet, 4 inches	long
14	"	2" x 4"	"	8 "	long
7	"	2" x 6"	"	8 "	"
2	"	6" x 6"	"	12 "	"
2	"	6" x 6"	"	14 "	"
70	"	1" x 6"	"	14 "	"
2	"	2" x 12"	"	12 "	"
8	"	1" x 12"	"	16 "	"
10	"	2" x 4"	"	8 "	"
4	"	2" x 4"	"	12 "	"
6	"	1/2" x 3"	"	16 "	"

The carpenter who constructed this feeder was paid $60 per month. Calculating the value of his time on this basis the labor bill for the building was $12.25.

A watch made of the cattle on November 20 indicated that they came to the self-feeder only in the afternoons. When first seen in the morning at 6: 30 they were still lying down but soon got up and moved to a sunny portion of the field and again lay down. They did not materially change position again till nearly one P.M., only getting up once or twice to feed a little on the grass in a half-hearted way. At one P.M. they came in a bunch to the feeder when they drank rather heartily then leisurely started feeding on the grain. They ate more or less continuously for an hour when they ceased such active operations, taking five or ten minute intervals of rests between shorter periods of feeding

The periods of rest became longer and the feeding period shorter till at 6 P.M. all but two steers went about ten rods away and lay down. The two remaining ate a little, then drank a little and followed. Occasionally during the afternoon the cattle drank. At about 5 P.M. a half bale of hay was given them in a bunk near the feeder . They ate upon this quite continuously for forty-five minutes.

After they were apparently settled for the night the feed in the troughs was made into ridges in peculiar designs so that if they fed during the night we would have evidence of it by the erasing of the ridges. At 6 A.M. the following morning the markings were still perfect showing that during the night the cattle had not come to the feeder.

It must be borne in mind that this record of the cattle was taken at the end of the feeding period when the roughage formed a small proportion of the ration. During the earlier part of the feeding the cattle were much more active.

The program for the hand-fed cattle on November 20 was much the same as for the self-feeder lot. They remained quietly in the center of the pasture till the self-feeder lot came up to eat when they also came. After drinking they pastured and rested till 5 P.M. when they were fed grain and one half bale of hay. They ate the grain greedily and continuously for half an hour when two dropped out to feed upon the hay for a few minutes. Others followed in rapid succession but each returned to the grain after a few minutes. After forty-five minutes all the steers were dividing their time about equally between the hay and corn and but

about fifty pounds of the grain remained. As the meal in the bunk became thinner and more difficult to get they spent more time with the hay. After an hour and a half the corn was entirely consumed and in another half hour the hay had disappeared, when the whole lot went off toward the center of the field and lay down for the night.